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Abstract

This paper develops the concept of *epistemic frames* as a mechanism through which students can use experiences in video games, computer games, and other interactive learning environments to help them deal more effectively with situations outside of the original context of learning.

Building on ideas of *islands of expertise* (Crowley & Jacobs, 2002), *communities of practice* (Lave & Wenger, 1991), and *ways of knowing* (Broudy, 1977), epistemic frames are described as the ways of knowing, of deciding what is worth knowing, and of adding to the collective body of knowledge and understanding of a community of practice. Data from two experiments (Shaffer, 2004a, 2004b, 2005) are used to show that students can incorporate epistemic frames into their identities when engaged in extended educational role-playing games. Epistemic frames are thus proposed as a possible mechanism through which sufficiently rich experiences in computer-supported games based on real-world practices may help students deal more effectively with situations in the real world and in school subjects.

Epistemic frames for epistemic games

Learning from a game

In this paper, I propose a mechanism for understanding how students can use experiences in video games, computer games, and other interactive learning environments to help them deal more effectively with situations outside of the original context of learning. That is, I propose a mechanism for what is sometimes referred to as *transfer*. With the goal of shedding light on the process of transfer more generally, I look here at two experimental educational role-playing games and what students carried from their experiences in these games back into school and into the broader curricula of their lives. The data presented are intended to be illustrative rather than definitive, and my focus is on stimulating further work by describing a theory to account for how a small set of students developed useful real-world skills and understandings in computer-supported role-playing games.

I begin with the experience of one young woman, whom I'll call Natalie. Natalie was a player in Escher's World, a role-playing game in which middle school students worked as graphic artists in a simulated, computer-aided design studio. The game lasted four weeks during the summer, during which time Natalie and the other players prepared a museum exhibit of digital designs. The activities of the game were modeled explicitly on the real-world practices of designers—specifically, on the activities and forms of interaction in a design studio (Shaffer, in press-b) This experiment has been described in detail elsewhere (Shaffer, 1997, 2004a, 2005), but suffice it to say here that students had an intense and intensive experience playing the role of graphic designers in this computer-based game, and that they (not surprisingly) developed some understanding of mathematics and design in the process.

I start with Natalie because of a conversation I had with her late in the fall, several months after the conclusion of the experiment. Natalie's work on a variety of assessment instruments in her follow up interview that fall showed that changes in her understanding of the "content" of the game had persisted over time. She was still better at solving problems in transformational geometry and graphic design than she had been before the game. More striking, though, was how confident Natalie seemed relative to her demeanor over the summer. I asked her about a new pager she was wearing prominently, and she replied proudly that her parents had bought it for her because she was "getting all A's in all my subjects."

I knew from pre-interviews that Natalie had not been an A student the previous year, so I asked what had changed in her schoolwork. She said the difference was that now "I raise my hand at every single question... Last year, I [was] like, 'No, please don't call on me!' Now my teacher doesn't want to call on me any more." She went on to describe in some detail how her attitude had changed in each of her classes because of her participation in the experiment.

There are any number of reasons to be wary about reading too much into comments such as Natalie's. But they do suggest that games such as Escher's World can accomplish, in a very general but very important sense, the elusive educational goal of producing worthwhile effects that transfer from one context to another (Bransford, Brown, & Cocking, 2000)—in Natalie's case, from a summer role-playing game using mathematics and digital art to performance in school more generally.

To explain how games and other immersion experiences accomplish this important goal, I build on the theory of *islands of expertise* (Crowley & Jacobs, 2002) to develop the concept of *epistemic frames* as a mechanism through which students use experiences in one context to help them deal with new situations. In the sections that follow, I first use excerpts from my

conversation with Natalie to describe and extend idea of islands of expertise. I then discuss the theoretical underpinnings of the concept of epistemic frames. I use another role playing game, The Pandora Project (Shaffer, 2004b), to illustrate how one might begin to observe epistemic frames in action. And although at this stage evidence regarding epistemic frames is preliminary rather than conclusive, I end the paper by discussing some of the potential implications of the concept for the development of educational games, and for our understanding of learning more generally.

Islands of expertise

Crowley and Jacobs (2002, p. 333) define an island of expertise as “any topic in which children happen to become interested and in which they develop relatively deep and rich knowledge.” These areas of connected interest and understanding, they suggest, create “abstract and general themes” that become the basis of further learning, both within and around the original topic area, and potentially in domains further afield (p. 334). They provide several examples of such islands, including a boy who develops relatively deep content knowledge and a “sophisticated conversational space” (p. 335) about trains and related topics after he is given a *Thomas the Tank Engine* book: the boy likes the book and asks to read it over and over; his parents buy him a Thomas the Tank Engine toy, and rent Thomas the Tank Engine videos for the boy to watch; the boy dresses as Thomas for Halloween; the family takes a trip to a local train museum where the boy gets a t-shirt with a picture of Big Boy, a gigantic steam locomotive; they check out more advanced library books on trains; the boy and his mother talk about steam from a kettle as being “just like a train.”

Crowley and Jacobs focus on how the islands of expertise in museums and other informal settings are constructed using *explanatoids*: short fragments of explanatory talk, typically between parent and child. Islands of expertise, they argue, develop as the culmination of a long series of collaborative interactions that are opportunistic and relatively unremarkable when viewed individually, but which collectively create a powerful linkage between understanding and interest. Crowley and Jacobs do not explicitly discuss the role of identity in this process, but it is implicit in their account—for example when the boy dresses up as Thomas or wears a t-shirt with a picture of a locomotive.

I have discussed elsewhere some of the mechanisms through which Natalie and the other participants in Escher’s World developed understanding about mathematics and design (Shaffer, 1997, 2004a, 2005). In the more structured setting of a summer program, linkages between interest and understanding were similarly created through a series of collaborative interactions with peers and experts. However, the interactions were smaller in number and organized more explicitly—and thus were characterized by fewer interactions that were more deliberate and less opportunistic than in Crowley and Jacob’s examples.

Here, however, I am more interested in using Natalie’s example as a window into some of the ways in which this island of expertise in mathematics and design, once developed, became a vehicle for learning in other areas. As Natalie and I spoke three months or so after the conclusion of the game, she provided a number of examples of how her work in Escher’s World had become part of her school experience more generally:

Natalie: I look at my [art] teacher’s artwork . . . and she says, “What’s your opinion, Natalie?” And I go, “You should put in more... symmetry in this, and the

balance out.” She was pretty amazed.... Some of my classmates, they don’t [say much more than:] “Wow, it’s a picture. It’s colorful.” But I tell my friends, “When you look at it carefully, it seems interesting.” I tell them all these words I learned, like the [mirror lines] and patterns.

Interviewer: How do [your friends] respond?

N: “Whoa, Natalie, where did you learn all this...?” Now I’m teaching them art. They really want to learn stuff about art. I think that because of this program I’m getting all A’s in all my subjects.

I: How come?

N: I don’t know. I seriously don’t. Maybe things I remembered, or the way I’m talking to teachers about all this. I don’t know. It’s a weird feeling.... In music class, we brought up art, because they say that music is art. And from this program, they think art is math. So I brought up the symmetry, and the music is symmetry and balancing. They told me after school, “Now I have a different way of looking at music....” We’re doing a lot of artwork in Spanish.... And my classmates, they’re not really good at art, but I’m the teacher’s helper, because I speak Spanish too. And I tell everybody, “But look at this. Just imagine like this, and how it balances out, and the colors....” [In] Science. The math. I’m learning percents and degrees, angles. We’re supposed to be learning in math. That’s

helped me understand better. Because I was usually shaky in that part, and now I'm pretty stable at that.

I: [Do you feel differently] about presenting your work in public, showing it to other people, talking about it?

N: That's easy. Dad has a video camera. I used to be not photogenic, and now it's like, "Hi, don't forget me." And students, they'll take pictures of me. I'm like, "Don't forget me in the picture." And presenting, I had critics. So that's a big thing.... Now I'm loud-spoken in public speaking, and pronouncing every single word, with no stumbles. Last year I was like, "Uhhh." [Makes a shivering sound.]

Natalie's examples suggest at least four mutually-reinforcing effects that the island of expertise in math and art had on her subsequent school experiences:

1. Specific elements of domain knowledge in mathematics and art developed in Escher's World helped Natalie work in these subjects. In math class, she felt more confident "learning percents and degrees [and] angles." Similarly, she is teaching her friends about art, showing them how "when you look at [art] carefully, it seems interesting."
2. This domain knowledge was closely associated with a particular way of seeing the world. A persistent theme in Natalie's description of her experiences in school following the workshop is on the close reading of works of art: on how attention to details of form and composition give her insight and help construct her as an expert in the eyes of peers and teachers. She described with pride the response of her friends

- (“Whoa, Natalie, where did you learn all this?”), and that her art teacher “was pretty amazed” at how much she knows about design principles.
3. This way of seeing that helped construct Natalie as an expert to her peers, her teachers, and to herself, and gave her points of entry into new domains. She described having “a different way of looking at music” by using ideas about symmetry. In Spanish class, her recognized expertise and interest in art gave her a role as “teacher’s helper” as the class discussed artwork as part of the curriculum.
 4. Finally, interest and expertise supported the transfer of more general practices from the workshop to the school setting. An important element of design is public discussion of work in progress. Natalie’s experiences in the workshop—supported by her understanding of mathematics and art and by her new identity as an expert in these areas—helped her become an active participant in all her classes.

I do not have data about how deep or long-lasting these effects were—although the pattern had apparently been going on for several months and had been effective in raising Natalie’s grades considerably. My focus here is on recognizing that the island of expertise Natalie developed was a combination of content knowledge and interest in a topic, as Crowley and Jacobs described, but also the explicit development of an identity of expertise and the association of that expertise with particular practices. Moreover, this nexus of content, interest, identity, and particular practices were developed together around a particular way of knowing—or perhaps more aptly in Natalie’s case, a particular way of seeing: of knowing where to start looking at new situations. As Natalie approached her schoolwork in a variety of subjects, the island of expertise she developed around mathematics and design gave her something to say and

a way of speaking about it—and in the process an identity as someone who had something worth saying. Natalie’s island of expertise was thus organized, I argue, around an epistemic frame.

Epistemic frames

Lave and Wenger (1991) describe a community of practice as a group of individuals who share a repertoire of knowledge about and ways of addressing similar (often shared) problems and purposes. In the process of participating in the practices of such communities, individuals reframe their identities and interests in relation to the community. That is, students who work as designers of mathematical art incorporate new ways of working into their sense of self, coming to think of themselves, at least in part, as designers—and, in particular, as designers interested in and able to use mathematics.

Pedagogical praxis extends the idea of communities of practice by suggesting that different communities of practice (for example, different professions) have different epistemic frames: different ways of knowing, of deciding what is worth knowing, and of adding to the collective body of knowledge and understanding of the community (Shaffer, 2004a). Broudy (1977) argues that the oft-discussed concepts of knowing *that* and knowing *how*—of declarative and procedural knowledge—are incomplete without the capacity of “knowing *with*,” which he describes as providing “a context within which a particular situation is perceived, interpreted, and judged” (p. 12). In these terms, epistemic frames are the ways of knowing *with* associated with particular communities of practice. These frames have a basis in content knowledge, interest, identity, and associated practices, but epistemic frames are more than merely collections of facts, interests, affiliations, and activities. Extending Broudy’s terminology, epistemic frames are a form of knowing *with* that comprise, for a particular community, knowing *where* to begin

looking and asking questions, knowing *what* constitutes appropriate evidence to consider or information to assess, knowing *how* to go about gathering that evidence, and knowing *when* to draw a conclusion and/or move on to a different issue. Following Brown and Campione (1996), I have argued elsewhere (Shaffer, 2004a, 2005, in press-b) that such ways of knowing form a coherent core around which effective practices are organized.

This concept of epistemic frames is related to but distinct from the sense in which other theorists have used the concept of epistemology. An epistemic frame is a broader concept, for example, than Perkins' (1992) *epistemic understanding*, or Schwartz and Sherin's (2002) and Collins and Ferguson's (1993) *epistemic structures*. Perkins defines epistemic understanding as "knowledge and know-how concerning justification and explanation in the subject matter" (p. 85). As such, it is co-extant with—but distinguished from—knowledge of facts, routine procedures, problem-solving strategies, and inquiry skills. Schwartz and Sherin, building on work by Collins and Ferguson, describe epistemic structures as a combination of *epistemic forms* (abstract forms of knowledge or schemata appropriate to a discipline) and *epistemic games* (rules for manipulation of these forms). In contrast, epistemic frames include methods for justification and explanation, and forms of representation, but orchestrated with strategies for identifying questions, gathering information, and evaluating results, as well as self-identification as a person who engages in such forms of thinking and ways of acting.

If epistemic understanding and epistemic structures form the core of disciplines or subjects such as mathematics or history, then epistemic frames are the organizing principle for practices. Geometers, economists, statisticians, and engineers (all of whom use mathematics) have distinct epistemic frames that incorporate different epistemic understandings and structures from the domain of mathematics. Developing expertise thus implies developing expertise of

some particular kind, from some particular perspective, relative to the ways of knowing of some community of practice. An island of expertise is local to a particular topic—perhaps a domain of inquiry, but at first more likely some piece of a domain that a student finds particularly compelling. But building such an island necessitates developing (or beginning to develop) an epistemic frame, which has the potential to be applied to other contexts.

In the next section of the paper, I present data from The Pandora Project, a role-playing game in which students developed islands of expertise in the science and ethics of xenotransplantation (the transplantation of organs from one species to another) by engaging in the practices of professional mediators. As with Escher's World, The Pandora Project has been described in more detail elsewhere (Shaffer, 2004b). I use the data here to illustrate how as a result of developing an island of expertise as xenotransplantation negotiators, students came to think about issues of ethics and technology more generally using the epistemic frame of mediation.

Islands of expertise and the transfer of epistemic frames in The Pandora Project

In The Pandora Project, high school students learned human immunobiology and biomedical ethics in a computer-supported negotiation game modeled on the training of professional mediators (Susskind & Corburn, 2000). An important core of the epistemology of negotiation is that stakeholders in a dispute have legitimate conflicting interests, and the goal of negotiation is to reconcile those interests in an equitable manner given the constraints of the situation. The focus is on the parties involved in a problem, understanding their needs, and analyzing how proposed solutions impact their legitimate interests. In the project, students acted as lead negotiators for parties in a dispute concerning a fictitious company seeking governmental

approval to begin experiments with xenotransplantation, a controversial biomedical procedure to introduce organs from pigs into human patients as treatment for late-stage organ disease.

The training of professional mediators and negotiators involves simulated negotiations in which learners take on the roles of the stakeholders in fictitious disputes. In the simulated negotiation for xenotransplantation, the fictitious stakeholders were a biotechnology company that had developed the procedure, the National Government, and three non-governmental organizations: the World Health Organization, the Animal Rights Coalition, and the Patient Rights' Organization. The developers of a simulated negotiation identify the key issues in the dispute, and for each issue specify a set of possible outcomes. A confidential score of *utility points* is assigned to each option for each stakeholder, representing the value of that outcome for the stakeholder. Each stakeholder gets his or her highest score for a different set of outcomes to the issues in dispute. The negotiation takes place as the stakeholders trade options across the issues in dispute, trying to find a set of options that will satisfy the needs of all of the participants at the table.

In our experiment, fourteen 17- and 18-year-olds participated in a two-week school-based game. Following a general introduction to the issues of xenotransplantation and the framework of the simulated negotiation, students were assigned stakeholder roles in groups of three. They spent two class periods conducting research on their stakeholders' positions regarding xenotransplantation, and background information about genetics, epidemiology, and cell biology needed to assess potential problems raised by xenotransplantation. Based on this research, each stakeholder group prioritized the issues in the dispute as well as the options for each issue in the dispute from the point of view of its stakeholder's interests. Utility points for each role were computed using an algorithm that incorporated these prioritized lists. Students were then divided

into groups of five, with each student representing a stakeholder in one of three separate negotiations.

In pre-and post-interviews students were asked to discuss their views on biotechnology in general and xenotransplantation in particular.¹ They completed concept maps about xenotransplantation and also responded to four scenarios presenting moral dilemmas raised by xenotransplantation in other contexts: problems of cost/benefit analysis, differential risk/reward tradeoffs between developed and developing nations, individual and societal rights, and animal welfare.² In the next two sections I briefly summarize how these interviews showed that in the process of conducting the simulated negotiation: (a) students developed an island of expertise including understanding of and interest in xenotransplantation (and more generally in the ethical implications of technology), and (b) this island of expertise led to the development of an epistemic frame of mediation and dispute resolution, which students used to analyze moral dilemmas in other contexts.

Understanding of and interest in xenotransplantation

In the process of the simulated negotiation, students developed a better understanding of both the process of xenotransplantation and its social, economic, and personal consequences. Concept maps drawn by students showed significant change between pre- and post-interviews. Maps both had more nodes and more links in post-interviews. (Mean nodes pre=9.6, post=10.6; $p<.05$. Mean links pre=12.8, post=18.5; $p<.01$. See also Figure 1.)

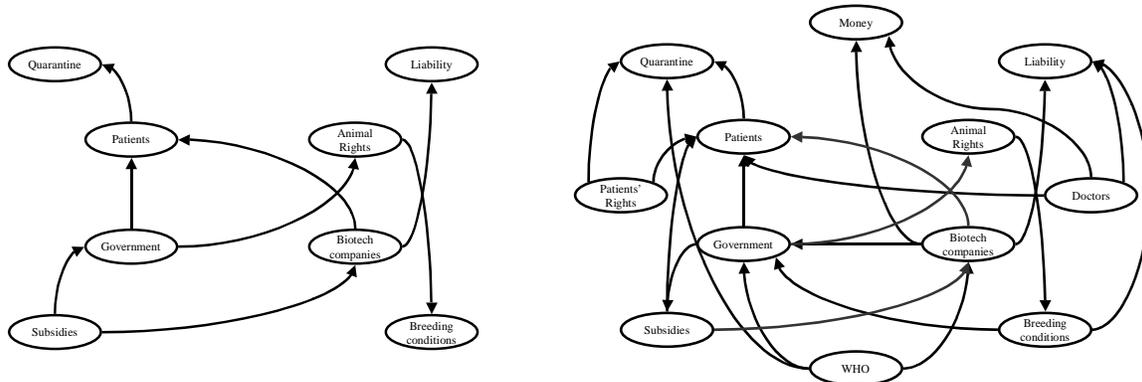


Figure 1: One student's concept maps from pre-interview (left) and post-interview (right) show a significant change in complexity of thinking about xenotransplantation.

Overall, 91% of the students (10/11) reported that they had changed their opinion about xenotransplantation over the course of the unit. The same proportion reported that they understood xenotransplantation better, and 55% (6/11) said that they now understood a range of perspectives on the questions raised by xenotransplantation. Moreover, 82% of the students (9/11) said they were interested in learning more about xenotransplantation and/or issues of ethics and technology more generally. As one student put it: "I think I definitely want to follow up on everything that we've done. Because it's really interesting. And it's really so powerful and so permanent in the science world that I think it would be a shame to just drop it."

Evidence that this interest and understanding was related to identity development was weaker, but interviews with students suggested that the structured negotiation (particularly the system of utility points) pushed students to take on the role of one of the stakeholders in the simulated dispute. As one student explained: "The points... forced me to think like a government official.... I had to, you know, adopt a stance that was government-like, and I had to defend it and find reasons for it. To try and defend myself, I had to take on Connor Andrews [the fictitious government negotiator] and think, like: 'What will we do? What would he say?'"

Development of the epistemic frame of mediation and dispute resolution

As described above, students responded in pre- and post-interviews to four scenarios presenting moral dilemmas raised by xenotransplantation in other contexts. For example, they were asked to respond to two versions of the following scenario:

A surgeon at the Altamore University Hospital has just developed a technique called “intrahost bone marrow transplantation.” Used in treating several forms of cancer, the treatment involves removing bone marrow from a patient and inspecting it cell-by-cell to separate healthy cells from cancerous cells. Once screened, the healthy bone marrow is grown in culture and returned to the patient to replace his or her diseased tissues. The procedure has a 5% success rate with patients for whom all other techniques have failed. However, it is extremely expensive, and some are concerned that it will divert resources from less expensive and more effective treatments for other diseases. What conditions, if any, should be imposed on the use of this new technique?

Before the negotiation about xenotransplantation, one student responded:

[D]iverting resources from less expensive and more effective treatments is definitely important.... [I]t definitely seems like it is a treatment that is effective... when all else has failed. Well, it definitely says hope.... I think it should be developed more, and... maybe they should be working on a technique that would be, you know, more cost effective, or I don't know.

This student's response is notable in several ways. First, it is vague. What is the "it" that "says hope"? Second, the solution proposed—"they should be working on a technique that would be, you know, more cost effective"—is essentially that the problem should be addressed by coming up with something better. Both of these characteristics changed when the same student responded to a similar scenario two weeks later, after the negotiation game:

I think that the doctors are right... to be concerned that money is going to go to this research. But I would almost be inclined to allow this treatment to continue only if [the company that is developing it is] paying for everything but no money is taken away from other techniques. Since it only has a 5% success rate I would be more inclined to not even mention it to patients.... [because] at the very end people would be really willing to do things that if they were more conscious of what was happening they might not have agreed to.

Here we see the response is more specific: the student identifies particular stakeholders (doctors, the company, patients) and the concerns they have regarding the problem. Moreover, the solution proposed is not merely to make the technique better, but one that tries to simultaneously address the concerns of these various stakeholders identified.

Students' answers to moral dilemmas such as these showed that participation in the simulated negotiation game helped players think about ethical dilemmas using the epistemic frame of professional negotiation and dispute resolution. In particular, students began to analyze disputes in terms of legitimate conflicting interests of stakeholders, focusing on understanding

the needs of the parties affected by a problem. Before the negotiation game, students' answers were more extended and analytical when they were *proposing a means to get more information* about the problem ($R^2=0.85, p<0.01$). After the negotiation experience, in contrast, students' answers were more extensive and analytical when they were *considering a range of viewpoints from groups of people affected* by the proposed technology ($R^2=0.61, p<0.01$).

Discussion

Crowley and Jacobs (2002) suggest that islands of expertise based on understanding of and interest in a specific topic create “abstract and general themes” that students are able to use in other contexts. Here I add that islands of expertise include development of identity and adoption of practices associated with the ways of knowing of a particular community. That is, I argue that islands of expertise are organized around coherent epistemic frames, and that these frames—these ways of looking at the world associated with different communities of practice—are the “abstract and general themes” that students use to leverage experience in an island of expertise in new situations.

To return for a moment to Crowley and Jacobs' example: they argue that the boy who developed an island of expertise about trains did so through a particular set of practices—namely, the exchange of explanatoids. Just as participation in a graphic design role-playing game helped Natalie develop key elements of the epistemic frame of a graphic designer in looking at works of art, and participation in a negotiation game helped students in The Pandora Project develop key elements of the epistemic frame of mediation and dispute resolution, so visits to museums and libraries to learn about trains seem to have helped the boy develop what we might describe as an epistemic frame of a train enthusiast or hobbyist. Epistemic frames are the proverbial “hats” or “glasses” we don as we take on a variety of identities or perspectives in

dealing with different situations. Once students learn to think like designers, or mediators, or train enthusiasts, they can (and do) use the ways of knowing embedded in these practices in other contexts.

Epistemic frames thus include, but are a broader concept than, epistemic understanding, epistemic forms, and epistemic games. An epistemic frame is more akin to Foucault's (1972) well-known concept of *episteme*. The episteme of an era, for Foucault, is the relationship between discursive practices (patterns of discourse or forms of interaction) and structures of knowledge (which for Foucault are always intertwined with the organization of power). Episteme exists at the level of the culture, across domains of knowledge and forms of practice. Epistemic frames may represent a similarly tight linkage between practices and ways of knowing, but at the level of the local cultures developed by individual communities of practice.

The data here are clearly illustrative rather than conclusive. Nonetheless, they do suggest that islands of expertise and epistemic frames may be useful ways to think about the potentially broad effects of experiences in well-designed educational role-playing games and other immersive environments. The ability of students to incorporate epistemic frames into their identities (or portfolio of potential identities) suggests a mechanism through which sufficiently rich experiences in technology-supported simulations of real-world practices (such as the games described above) may help students deal more effectively with situations in the real world and in school subjects beyond the scope of the interactive environment itself.

The concept of an epistemic frame suggests that we can construct *epistemic games*—not in the more limited and technical sense that Collins and Ferguson (1993) suggest, but games that are based on the epistemic frames of socially-valued practices (Shaffer, in press-a). Because they develop epistemic frames of important communities of practice, such games have the potential to

help students develop ways of thinking that persist beyond the game environment, and, as happened in Escher's World and The Pandora Project, shape students' thought and action more broadly. Epistemic games based on the ways in which professionals acquire their epistemic frames may thus provide an alternative model for organizing our educational system. Epistemic games make it possible for students to learn through participation in authentic recreations of valued work in the world, and thus give educators an opportunity to move beyond disciplines derived from medieval scholarship constituted within schools developed in the industrial revolution—a new model of learning for a new mode of learning through immersive game technologies.

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Footnotes

¹ For logistical reasons, only 11 of the 14 students were able to complete both pre and post interviews.

² Two forms of each scenario were developed. Forms were randomized between pre and post interview for each student, and scenarios were given to students in a random order.

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